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Theoretical Model of the Lumbar Spine Musculature

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Editorial

The complexity of the spine makes an entire understanding of its mechanical function difficult, particularly since the stresses and strains can't be measured directly with non-invasive techniques. To explain the behaviour of the spine and its various components, biomechanical models are used where in-vivo studies are impractical. All biomechanical models of the spine share one common feature; each must contains an anatomical model of the spine and a way of distributing force to the components during this anatomical model. There's little consistency between previous anatomical models with authors incorporating different numbers of muscles, using different measures of muscle area (physiological cross-sectional area (PCSA) or cross-sectional area (CSA)), grouping muscles differently with reference to activation and using values between 30 N cm^{-2} and 100 N cm^{-2} for the utmost muscle force intensity. Most of those differences stem from a scarcity of detailed anatomical information for the muscles of the lumbar spine.

Without a 'correct' anatomical model that reflects the complex anatomy of the region, the model is going to be deficient in some aspect regardless of the force allocation technique used. As an example, incorporating the detailed anatomy of the erector spinae muscle has the effect of reducing predicted spinal compression and shear, and also changing the direction of the shear. Predictions of spinal shear and compression are sensitive to changes in muscle lines of action, particularly during asymmetric loading and flexion. It's also been suggested that better correlations between model predictions and EMG data are often obtained from models incorporating accurate and detailed anatomy. This paper describes a 3 dimensional anatomical model of the muscles of the lumbar spine. It incorporates the muscles reviewed by Hansen et al. also because the detailed structure of the interior and external oblique muscles and therefore the thoracolumbar fascia (TLF) thereby addressing a number of the problems noted previously.

To validate the proposed model, a pseudo force distribution technique is applied. This same technique is used to explore biomechanical changes resulting from surgical injuries. The development of a comprehensive and detailed model of the musculature of the lumbar region is required if biomechanical models are to accurately predict the forces and moments experienced by the lumbar spine. Methods a replacement anatomical model representing the nine major muscles of the lumbar spine and therefore the thoracolumbar fascia is presented. These nine muscles are modelled as numerous fascicles, each with its own force producing potential supported size and line of action. The simulated spine is fully deformable, allowing rotation in any direction, while respecting the physical constraints imposed by the structure. Maximal moments were predicted by implementing the model employing a pseudo force distribution algorithm. Three sorts of surgery that affect the spinal musculature were simulated: posterior spinal surgery, anterior surgery, and total hip replacement.

Findings Predicted moments matched published data from maximum isometric exertions in male volunteers. The biomechanical changes for the three differing types of surgery demonstrated several common features: decreased spinal compression and production of asymmetric moments during symmetric tasks. Interpretation this sort of study provides new opportunities to explore the effect of various patterns of muscle activity including muscle injury on the biomechanics of the spine.

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